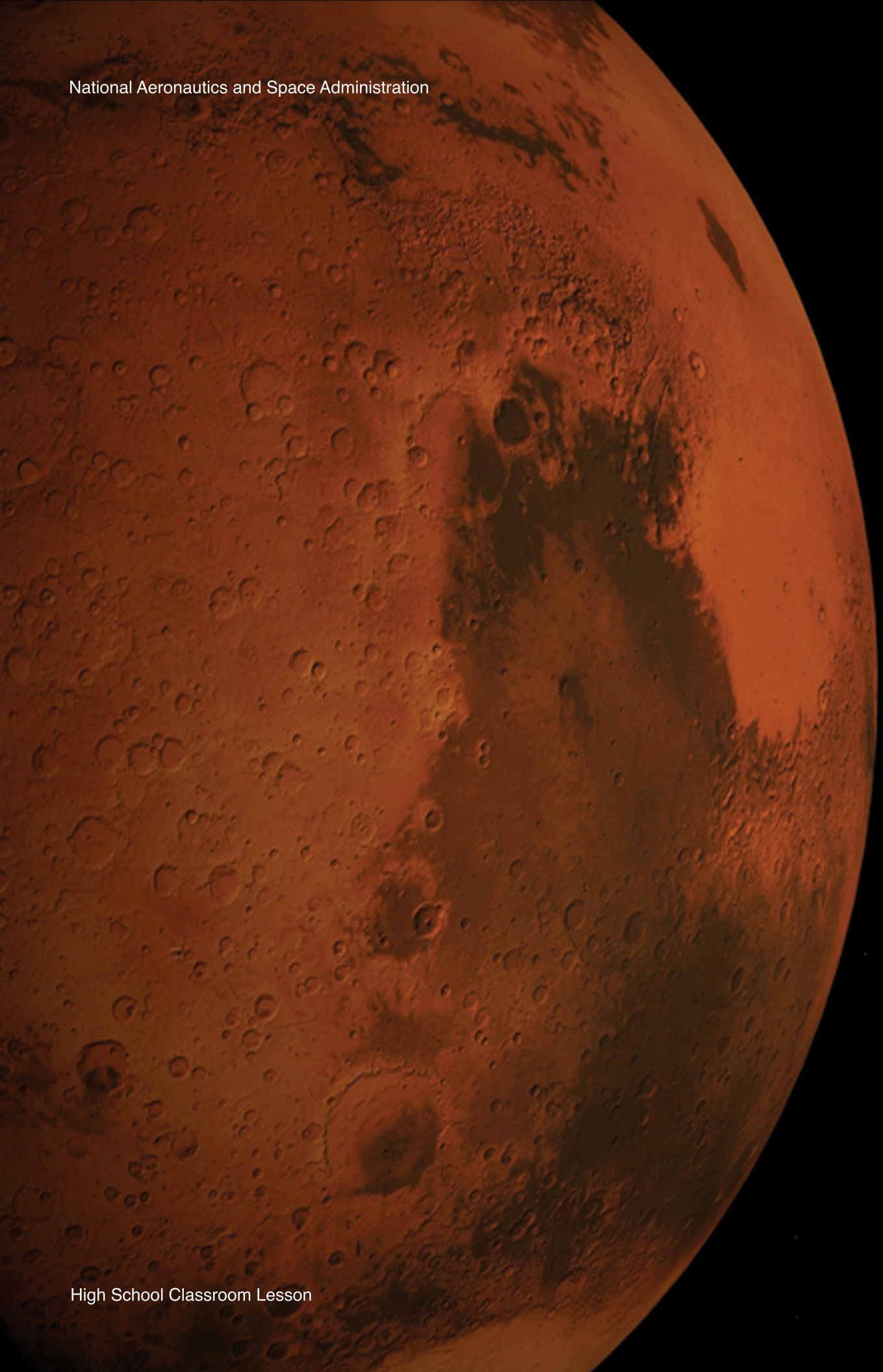
National Aeronautics and Space Administration



red rocks

High School Classroom Lesson

Red Rocks

Grades: 9-12 **Prep Time: ~10 min** **Lesson Time: ~65 minutes**

WHAT STUDENTS DO: Explore red rocks of Earth to explain why Mars is red.

Students will explore Karijini Gorge in Australia and Oak Creek Canyon in Sedona, AZ searching for clues to the environments that formed the red rocks there. They will observe these rock formations at a variety of scales to gather these clues. Finally, they will apply their understanding of red rock formation to answer the question "Why is Mars red?"

NRC FRAMEWORK/NGSS CORE & COMPONENT QUESTIONS

HOW AND WHY IS EARTH CONSTANTLY CHANGING?

NGSS Core Question: ESS2: Earth Systems

How do Earth's major systems interact?

NGSS ESS2.A: Earth Materials and Systems

INSTRUCTIONAL OBJECTIVES (IO)

Students will be able to

IO1: Interpret evidence in the rocks of Mars at a variety of scales to explain the presence of iron oxide and what it tells us about water in the ancient/present Martian environment.

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Last edited: April 25, 2018

1.0 Materials

Required Materials:

Please supply:

- Computer or Laptop – 1 per student
  - Supported Browsers: Chrome; Edge; Firefox; Safari

Please Print:

From Student Guide

(A) Reading Rock Evidence Recording Sheet – 1 per student
(B) Red Rocks Evaluation Recording Sheet – 1 per student

Optional Materials:

From Teacher Guide

(C) Reading Rock Evidence Recording Sheet (KEY)
(D) Red Rocks Evaluation Recording Sheet (KEY)

From Alignment Document

(N) Red Rocks Alignment Rubrics

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2.0 Lesson Timeline

***Red Rocks* Lesson Timeline**:

Time:

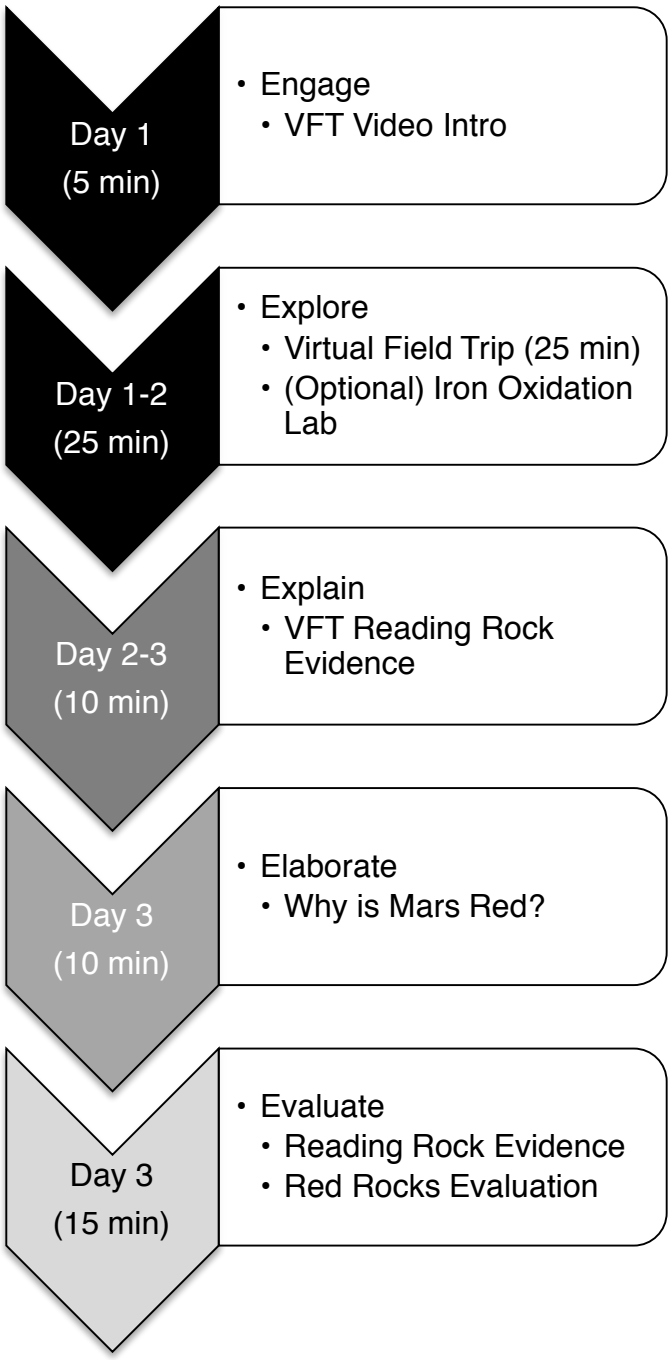
- 65 minutes

Materials:

- Student Guide pages

5-E Inquiry Process:

- The arrow color represents the 5-E step students will be primarily engaging in for that class session



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3.0 Vocabulary

analyze	consider data and results to look for patterns and to compare possible solutions
cementation	the process of hardening sediment through the precipitation of minerals between the pore spaces
compaction	the process of compressing sediment and reducing the amount of space (pore space) between the grains
composition	the chemical makeup of an object
compound	a substance formed by chemically combining two or more elements
cross-bedding	layers of sedimentary rock that are deposited at an angle compared to the surrounding horizontal layers
data	facts, statistics, or information
empirical evidence	knowledge gained through direct or indirect observation
explanations	logical descriptions applying scientific information
grains	small, hard particles or crystals resulting from weathering
hand sample	a rock sample that is typically the size of a hand, collected for further examination
igneous rock	rock that is formed through the cooling and solidification of magma or lava
macroscopic	large-scale and visible to the naked eye
mesoscopic	small or medium-scale; visible to the naked eye or using a low magnification hand lens
microscopic	extremely small scale that can only be seen with a microscope because they are so small
mission	a spacecraft designed to explore space, seeking to answer scientific questions
observations	specific details recorded to describe an object or phenomenon
predict	to declare what will happen based on reason and knowledge
scale	a comparative relation between objects such as size or distance
sedimentary rock	rock formed from the cementation of material deposited in oceans or on Earth's surface
thin section	a rock sliced so thin it allows light to pass through

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4.0 Procedure

PRIOR KNOWLEDGE & SKILLS

A. Periodic Table
B. Chemical Bonds
C. Compound Naming Conventions
D. Rock Types and their Formation
E. Observing Skills
F. Claim, Evidence, Reasoning Cycle

PREPARATION

A. Visit https://infiniscope.org/lesson/red-rocks/ for access to the digital learning experience, standards alignment documents, and additional resources.

B. Reserve computers or tablets for Exploration Days

C. PRINT THE FOLLOWING:

- Student **Recording Sheets (A-B)** – 1 per student

STEP 1: ENGAGE (~5 minutes)

Set Up the "Why is Mars red?" Question

A. Hand out or assign computers and ask students to access the Why is Mars Red? digital learning experience at https://infiniscope.org/ and choose "***Explore***" to launch the experience.

B. Students will access a video introduction in the beginning of the Red Rocks VFT, setting the stage to answer the question "Why is Mars red?" and explaining why we explore Earth to understand other planets and moons.

STEP 2: EXPLORE (~ 25 minutes for VFT only)

Red Rocks Virtual Field Trip and Oxidation Lab

A. Hand out ***(A) Reading Rock Evidence Recording Sheet.*** Students will complete this Recording Sheet as they work through the VFT.

B. If choosing the option of incorporating your own iron oxidation lab into this experience, allow students to follow the Red Rocks VFT until they reach the section titled "**RED ROCKS – GEOLOGY LAB OBSERVATIONS**". Students should stop here for the day. If not completing the optional activity, allow them to continue through to the end of the VFT.

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- **Classroom Management Tip:** In preparation for the next class period, ask students to click the restart button located in the top toolbar under the three horizontal lines. This will ensure your next group starts at the beginning of the VFT.

C. Prior to completing the remainder of the VFT, have students participate in an iron oxidation lab, so that they may observe iron oxide precipitate. This precipitate relates directly to the formation of iron oxide in these red rocks.

D. When students have completed the optional iron oxidation lab in class, they will be ready to complete the remainder of the VFT. When the students reopen the VFT, it will open at the beginning of the VFT. To advance past the opening they previously completed, ask them to type the word "oxidation" in the field that asks for their observations. This will automatically advance them to their new start screen.

- **Teacher Tip:** If students seem to be stuck in the activity, it isn't responding in a way that seems correct, or if an error occurs, students can attempt to refresh their browser or click the "Restart" button located in the upper right corner of the screen. "Restart" will clear all of their progress and bring them back to the start screen. Hitting the browser's "Refresh" button will not restart the activity.

- **Teacher Tip:** If you would like to analyze student interactions in this activity, you can sign up to join the ***Infiniscope Teaching Network*** (https://infiniscope.org/join/) and enroll your class into the activity. By enrolling, you will gain access to the analytics of the activity by student to see how students progressed through the activity. You also have the ability to adopt the activity and adapt it to the specific needs of your classroom, school, or community.

STEP 3: EXPLAIN (~ 10 minutes during VFT)

Reading Rock Evidence

A. While students are working through the Virtual Field Trip, they will complete ***(A) Reading Rock Evidence Recording Sheet*** using the data and information they have collected.

B. Many of these questions were addressed within the Virtual Field Trip. They should be a review of concepts for the students. You may also choose to discuss in class as opposed to completing the Recording Sheet.

- **Time Management Tip:** Should you run out of class time for students to complete this section there are a couple of options.

  - **Option 1:** If students are enrolled in the class through the Infiniscope Teaching Network, they can log in at home or at school at another time and pick up where they left off.

  - **Option 2:** Students can use the "oxidation" phrase to skip to the second half and complete the sections again at home or school at another time.

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STEP 4: ELABORATE (~ 10 minutes)
Why is Mars Red?

A. After exploring Karijini Gorge and Oak Creek Canyon VFT's, in addition to completing the optional iron oxidation lab in class, students will apply their understanding of sedimentary rocks and oxidation to the surface of Mars.

STEP 5: EVALUATE (~ 15 minutes)
Evaluate Evidence for Red Rock on Mars and Importance of Observational Scales

A. Take a few minutes to review ***(A) Reading Rock Evidence Recording Sheet*** and discuss what was found on Mars. Prior to completing the evaluation Recording Sheet, students should understand that Mars does not have red sedimentary rock, but instead it has sedimentary rocks and a thin layer of red dust covering the planet.

B. Hand out ***(B) Red Rocks Evaluation***.

5.0 Evaluation/Assessment

Use the *(N) Red Rocks Alignment Rubric* as a formative assessment, allowing students to improve their work and learn from mistakes during class. The rubric evaluates the activities using the Learning Outcomes identified in the Alignment Documents for the activity.

6.0 Extensions

1. Investigate iron ore production across the globe, the process used to separate iron and oxygen, and propose a way to use the iron oxide of Mars as a raw material for human exploration of the planet.

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(A) Reading Rock Evidence Recording Sheet

Name: _____

Instructions:

Complete the following based on what you've discovered in the Red Rocks VFT.

1. Describe the characteristics used to identify sedimentary rocks.

   _____

   _____

2. What can be seen at each scale?

	Karijini Gorge	**Oak Creek Canyon**
Macroscale Observations		
Mesoscale Observations		
Microscale Observations		

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(B) Red Rocks Evaluation Recording Sheet

Name: _____

Answer the following questions based on the Red Rocks Virtual Field Trip.

1. Explain the importance of observing at a variety of scales, microscale – macroscale.

_____

_____

_____

_____

2. Why is Mars red? What evidence can you use to support your claim?

_____

_____

_____

_____

3. Which iron oxide environment is similar to the environment of Mars, Karijini Gorge, Western Australia or Oak Creek Canyon, Sedona? What evidence (micro – macro) can you point to that supports your claim? Include an introduction, scientific language to clarify your claim, use formal style, and provide a concluding sentence. (Use separate paper if necessary).

_____

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(C) Reading Rock Evidence Recording Sheet (KEY)

Instructions:

Explain the following concepts based on what you've discovered in the Red Rocks VFT.

1. Describe the characteristics used to identify sedimentary rocks.

   Layering, cross-bedding, sediment, grain size, oxidation

2. What can be seen at each scale?

	Karijini Gorge	Oak Creek Canyon
Macroscale Observations	***shows large scale layering (bedding), different colors and thicknesses of layers***	***shows large scale layering (bedding) such as cross-bedding, different colors and thicknesses of layers***
Mesoscale Observations	***shows fine layering, fine colored layers and thicknesses***	***shows grain size, fine layering, fine colored layers and thicknesses***
Microscale Observations	***shows layers and can identify the chemical composition of the individual components***	***shows individual grains and can identify the chemical composition of the individual components***

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(D) Red Rocks Evaluation Recording Sheet (KEY)

Answer the following questions based on the Red Rocks Virtual Field Trip.

1. Explain the importance of observing at a variety of scales, microscale – macroscale.

   Observing at a variety of scales gives additional data you cannot observe at the other scales. It provides a greater opportunity to interpret the past environment using all data that is available in the rock record.

2. Why is Mars red? What evidence can you use to support your claim? ***Oxidation of iron at the surface. Not embedded in rock, it is loose dust exposed to water and oxygen at the surface only.***

3. Which iron oxide environment is similar to the environment of Mars, Karijini Gorge, Western Australia or Oak Creek Canyon, Sedona? What evidence (micro – macro) can you point to that supports your claim? Include an introduction, scientific language to clarify your claim, use formal style, and provide a concluding sentence. (Use separate paper if necessary)

   Neither – the sedimentary rock of Mars is not oxidized, the dust is; therefore it's environment was different from both Karijini and Oak Creek Canyon. It did not have an iron-rich ocean that reacted with oxygen, nor groundwater flowing through the oxidized sedimentary rock.

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